

therefore, the bumps 3 are brought in direct contact with the electrodes 5 at the time of bonding. Then, neither the anisotropic conductive film sheet 10 nor the thermosetting adhesive 6b enters spaces under the electrodes 5, and the value of connection resistance between the bump 3 and the electrode 5 can be reduced. If the circuit board side is heated, then the temperature of the bonding head 8 can further be reduced. If this method is applied to the third embodiment, the bonding of the gold bumps to the gold electrodes (for example, copper or tungsten plated with nickel or gold) of the circuit board can easily be achieved.

(Sixth Embodiment)

A method and apparatus for mounting an electronic component of, for example, an IC chip on a circuit board and an electronic component unit or module of, for example, a semiconductor device in which the IC chip is mounted on the board by the mounting method, according to a sixth embodiment of the present invention will be described next with reference to Fig. 10 and Fig. 11. The sixth embodiment differs from the first embodiment in that high-reliability bonding can be achieved even if a bump 103 is mounted on the electrode 5 of the circuit board 4 while being shifted.

According to the sixth embodiment, as shown in Fig. 10A, a gold ball 96 is formed of a gold wire 95 by an

electric spark similarly to the wire bonding in forming the bump 3 on the IC chip 1. Next, a ball 96a of a diameter  $\Phi$ d-Bump denoted by 95a is formed while adjusting the size of the ball by the duration of the electric spark, and the 5 thus-formed ball 96a of the diameter  $\Phi$ d-Bump is formed by controlling the parameter of time or voltage for generating the electric spark so that a chamfer diameter  $\phi$ D denoted by 93a of a capillary 193 whose chamfer angle  $\theta$ c is not greater than  $100^\circ$  becomes one-half to three-fourths the 10 gold ball diameter d-Bump. Instead of forming a bump 3 as shown in Fig. 10D with the provision of a flat portion 93b in the portion to be brought in contact with the gold ball 15 of the capillary 93 as shown in Fig. 10C, a bump 103 as shown in Fig. 10B is formed on the electrode 2 of the IC chip 1 by supersonic wave thermocompression-bonding by means of a capillary 193 whose tip shape has a tip portion 193a provided with no flat portion in the portion to be brought in contact with the gold ball 96a of the capillary 193 as shown in Fig. 10A. By using the capillary 193 20 having the above-mentioned tip shape, an approximately conically tipped bump 103 as shown in Fig. 10B can be formed on the electrode 2 of the IC chip 1. Even when the approximately conically tipped bump 103 formed by the above-mentioned method is mounted on the electrode 5 of the 25 circuit board 4 while being shifted as shown in Fig. 11C,

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the bump 103 can be partially brought in contact with the electrode 5 of the board 4 without fail since the bump 103 has the approximately conically shaped tip so long as the shift is not greater than half the outside diameter of the bump 103.

In contrast to this, in the case of a bump 3 as shown in Fig. 11D, when the bump 3 is mounted on the electrode 5 of the circuit board 4 while being shifted by a dimension Z as shown in Fig. 11C, the so-called base 3g of a width dimension d partially comes in contact with the electrode 5 as shown in Fig. 11E. However, this contact is mere partial contact, leading to bonding in an unstable contact state. If the board 4 is subjected to a thermal shock test or reflow in the above unstable bonding state, then the bonding in the unstable bonding state may result in becoming open, that is, defective bonding. In contrast to this, according to the sixth embodiment, even when the approximately conically tipped bump 103 is mounted on the electrode 5 of the circuit board 4 while being shifted by the dimension Z as shown in Fig. 11C, the bump 103 can partially come in contact with the electrode 5 of the board 4 without fail so long as the shift is not greater than half the outside diameter of the bump 103 since the bump 103 has the conical tip shape, and this can prevent the possible occurrence of the defective bonding even when the

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